USER'S MANUAL
Rev. 11/2009

REVO *M*

FROM 60A TO 210A

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1 Important warnings for safety

This chapter contains important information for the safety. The not observance of these instructions may result in serious personal injury or death and can cause serious damages to the Thyristor unit and to the components system included.
The installation should be performed by qualified persons.

The Thyristor unit are integral part of industrial equipments. When it is supply, the Thyristor unit is subject to dangerous tensions.

- Don't remove the protection Cover.
- Don't use these unit in aerospace applications and/ or nuclear.

The nominal current corresponds to use at temperature not superior to 45°C.

- The Thyristor unit must be mounted in vertical position and without obstruction above and below to allow a good flow ventilation.
- The hot air of one thyristor unit must not invest the unit positioned above.
- For side by side placed leave a space of 15mm between the unit.

A suitable device must ensure that the unit can be electrically isolated from the supply, this allows the qualified people to work in safety.

Protection (Protection, Protezione)
The unit have IP20 protection rating as defined by the specific international. Is necessary consider the place of installation.

Earth (Terre, Messa a terra)
For safety, the Thyristor unit with isolated heat-sink must be connected to earth.
Earth impedance should be correspondent to local earth regulation. Periodically the earth efficiency should be inspected.

Electronic supply (Alimentation électronique, Alimentazione elettronica)
The electronic circuit of the Thyristor unit must be supplied by dedicated voltage for all electronic circuits and not in parallel with coil contactors, solenoids and other.
It's recommended to use a shielded transformer.

Electric Shock Hazard (Risque de choque électrique, Rischi di scosse elettriche)
When the Thyristor unit is energized, after the power supply is shut off, wait least a minute for allow the discharge of the internal capacitors where there is a dangerous tension. Before working, make sure that:

- Only authorized personnel must perform maintenance, inspection, and replacement operations.
- The authorized personnel must read this manual before to have access to the unit.
- Unqualified People don't perform jobs on the same unit or in the immediate vicinities.

Important warnings (Attention, Avvertenze importanti)
During the operations with units under tension, local regulations regarding electrical installation should be rigidly observed:

- Respect the internal safety rules.
- Don't bend components to maintain insulation distances.
- Protect the units from high temperature humidity and vibrations.
- Don't touch components to prevent electrostatic discharges on them.
- Verify that the size is in line with real needs.
- To measure voltage current etc. on unit, remove rings and other jewels from fingers and hands.
- Authorized personnel that work on thyristor unit under power supply voltage must be on insulated board

This listing does not represent a complete enumeration of all necessary safety cautions.

Electromagnetic compatibility
(Compatibilità électromagnétique, Compatibilità elettromagnetica)
Our thyristor units have an excellent immunity to electromagnetic interferences if all suggestions contained in this manual are respected. In respect to a good Engineering practice, all inductive loads like solenoids contactor coils should have a filter in parallel.

Emissions (Emission, Emissioni)
All solid-state power controllers emit a certain amount of radio-frequency energy because of the fast switching of the power devices.
The CD Automation's Thyristor unit are in accord with the EMC norms, CE mark.
In most installations, near by electronic systems will experience no difficulty with interference. If very sensitive electronic measuring equipment or low-frequency radio receivers are to be used near the unit, some special precautions may be required. These may include the installation of a line supply filter and the use of screened (shielded) output cable to the load.

2 Note

Warning: This icon is present in all the operational procedures where the Improper operation may result in serious personal injury or death

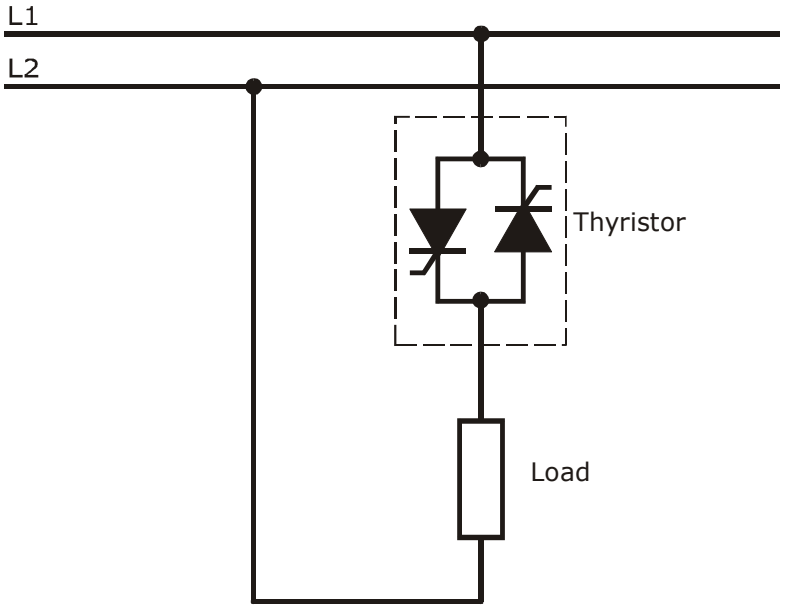
Caution: This icon is present in all the operational procedures where the Improper operation can cause damage for the Thyristor unit.

CD Automation reserves the right to modify the own products and this manual without any advise.

CE

3 Introduction

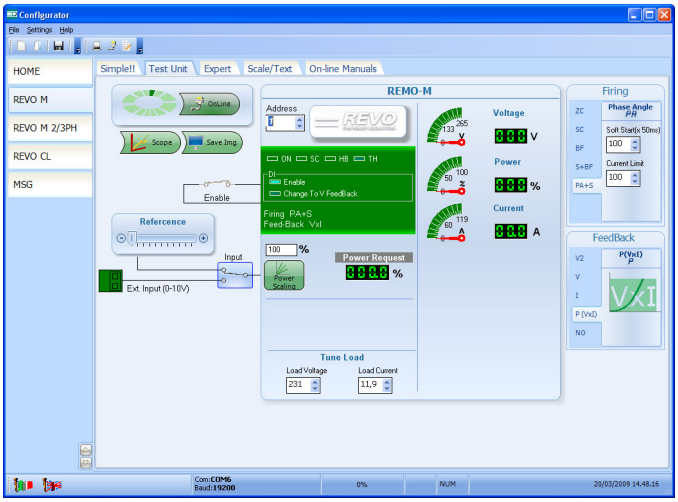
A thyristor unit is semiconductor device which acts as a switch formed by two thyristors in ant parallel. To switch on the alternating current the input signal will be on and the thyristor will switch off at first Zero Crossing voltage with no input signal.
The benefits of thyristor units compared with elettromechanical contactors are numerouses: no moving parts, no maintenance and capacity to switch very fast. Thyristors are the only solution to control transformers and special loads that change resistance with temperature and with age.



4 Advantages compared with analog thyristor unit

Communication RS485 is a standard feature of REVO M this allows the use of many information like: current, power, load state and all the parameters for diagnostic and configuration. Ulterior advantages of the digital system vs the analogical is the flexibility and the possibility of implement special characteristics without change the hardware. Several strategies can be implemented and selected through the configuration parameters.
With CDA software configuration, you can have access to the configuration parameters.
To connect the Thyristor unit to the computer use the USB\TTL converter.

5 Software Configurator CDA Thyristor configurator software



CDA Thyristor configurator software
is free and is possible download it from our site:
www.cdautomation.com

If the Order Code is in line with requirement, then REVO M has been already configured in Factory and it's ready to use.
You need the software only to modify the ordered configuration. Anyway we suggest to check the unit on the machine with the "Test unit" section.

For install the software, launch the program and follow the instructions on the screen.

Run the software configurator and set the serial port of the PC with con baudrate =19200(default) and the address of Thyristor unit (default=1).

To connect the unit at the PC, it's necessary use the USB\TTL converter connected between the unit and the USB port of the PC.

USB\TTL converter need a driver to work properly, you can find it at
www.cdautomation.com

Is available a full programmer kit composed by

- USB\TTL converter,
- Two cable
- CDA Thyristor configurator software
- USB driver

With the CD-RS serial converter is possible configure the Thyristor unit also through the RS485 For this solution, the programming cable is not necessary.

6 Quick Start

Attention: *this procedure must be carried out by skilled people only.*

If your REVO M code is in line with what you really need, then the main configuration is already done by CD Automation and you just need to do the following steps:

1. Verify REVO M's current sizing. Be sure that:
   - the load current is equal or less than the nominal one of REVO M
   - the main voltage is equal or less than the nominal voltage of REVO M
2. Verify the Installation
3. Verify the Wiring:
   - all auxiliary connections must be done in line with wirings on this manual
   - verify that there isn't a short circuit on the load
4. Supply the auxiliary voltage of the unit
   Set the parameters U_OP (Operative Voltage) and A_Lo (Nominal Current of the load) using the frontal keypad or CDA Thyristor configurator software.

	U_oP	**Operative Voltage**	**V**	**R/W**
Function:		It's necessary to specify the operative voltage		
Min/Max:		24 ÷ 1000V		
Default:		230		
Note:		With voltage up to 330V and over 600V, REVO M needs hardware modifications: specify this in phase of ordination.		

	A_Lo	**Load nominal current**	**A**	**R/W**
Function:		It's necessary to specify the load current value at nominal voltage. This current and voltage value are necessary to be able to read the power in engineering units		
Min/Max:		1 ÷ 100.0 Ampere (for size up to 100A)		
Default:		Nominal REVO M current value if load current has not been specified.		

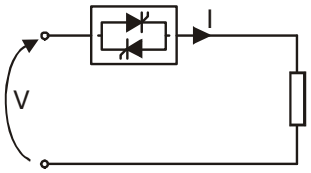
If your REVO M code is NOT in line with what you really need, use the enclosed configurator software tool to set-up the unit. Install the software on your PC, select REVO M and click on test unit changing what you need.

7 Basic Connections and sizing

Single phase wiring with resistive load (with REVO M-1PH)

$$I = \frac{P}{V}$$

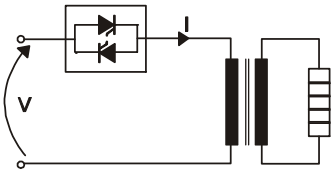
V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



Single phase wiring with inductive load (with REVO M-1PH)

$$I = \frac{P}{V \cos\phi}$$

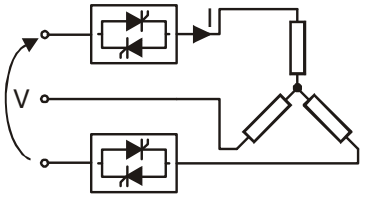
V = Nominal voltage phase to phase
I = Nominal current to the load
P = Nominal power to the load



Star wiring with resistive load (control on two phases with REVO M-2PH)

$$I = \frac{P}{1{,}73V}$$

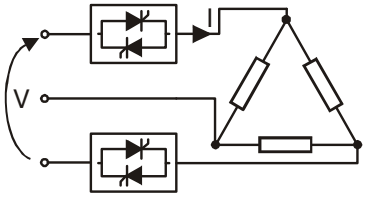
V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



Delta wiring with resistive load (control on two phases with REVO M-2PH)

$$I = \frac{P}{1{,}73V}$$

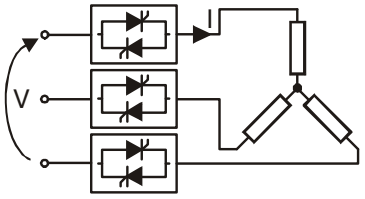
V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



Star wiring with resistive load (control on three phases with REVO M-3PH)

$$I = \frac{P}{1{,}73V}$$

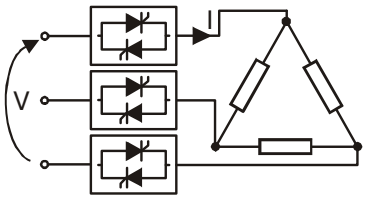
V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



Delta wiring with resistive load (control on three phases with REVO M-3PH)

$$I = \frac{P}{1{,}73V}$$

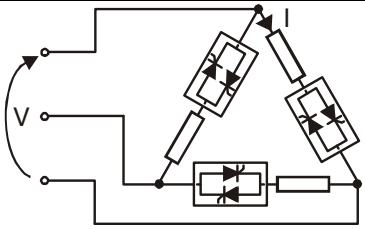
V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



Open Delta wiring with resistive load (with 3 X REVO M-1PH)

$$I = \frac{P}{3V}$$

V = Nominal voltage of the load
I = Nominal current of the load
P = Nominal power of the load



8 Identification and Order Code

8.1 Identification of the unit

Caution: *Before to install, make sure that the Thyristor unit have not damages. If the product has a fault, please contact the dealer from which you purchased the product.*

The identification's label give all the information regarding the factory settings of the Thyristor unit, this label is on the unit, like represented in figure.
Verify that the product is the same thing as ordered .

8.2 Order Code

	1	2	3	4	5	6	-	7	8	9	10	11	12	13	14	15	16
CODE	**R**	**M**	_	_	_	_	-	_	_	_	_	_	_	_	_	_	_
PHASES CONTROLLED																	
1PH			1														
2PH			2														
3PH			3														
CURRENT RATHING																	
60A With Heat-sink				0	6	0											
90A With Heat-sink				0	9	0											
120A With Heat-sink				1	2	0											
150A With Heat-sink				1	5	0											
180A With Heat-sink				1	8	0											
210A With Heat-sink				2	1	0											
MAX VOLTAGE																	
480V								4									
600V								6									
LOAD VOLTAGE AND AUX.VOLTAGE SUPPLY RANGE																	
90:130V									1								
170:265V									2								
230:345V									3								
300:530V									5								
510:690V									6								
INPUT																	
0-10V dc										V							
4-20 mA										A							
10k Pot										K							
SSR										S							
FIRING																	
ZC Zero Crossing											Z						
BF Burst Firing											B						
SC Single Cycle (only 1PH unit)											C						
S+BF Soft Start + Burst Firing1 (only 1PH unit)											J						
PA Phase Angle (only 1PH unit)											P						
PA+S Phase Angle + Soft Start (only 1PH unit)											E						
DT Delayed Triggering1 (only 1PH unit)											D						
CONTROL MODE																	
None												0					
V Voltage (available with BF,SC,S+BF and DT)												U					
VxI Power (available with BF,SC,S+BF and DT)												W					
OPTIONS																	
IFH (≤45A) or IF(>45A) + CT													Y				
IFH (≤45A) or IF(>45A) + CT + HB													H				
110V FAN OPTION																	
None														0			
110V fan option available ≥ 120A														1			
APPROVAL																	
None															0		
cUL us (soon available)															L		
MANUAL																	
None																0	
Italian																1	
English																2	
German																3	
French (soon available)																4	
VERSION																	
Version 1 standard																	1
Version 2 Special																	2

9 Internal Fuse

The thyristor unit have internal fuse extrarapid at low I²t for the thyristor protection of against the short-circuits.
The Fuses must have I²t 20% less than thyristor's I²t. The warranty of thyristor is null if no proper fuses are used.

Type	Fuse Code Spare Part	Current (ARMS)	I²T (A² sec.)	Vac
060	100FE	100	2800	660
090	FEE200	200	11400	660
120	FEE200	200	11400	660
150	FEE200	200	11400	660
180	URB315	315	82000	660
210	URB315	315	82000	660

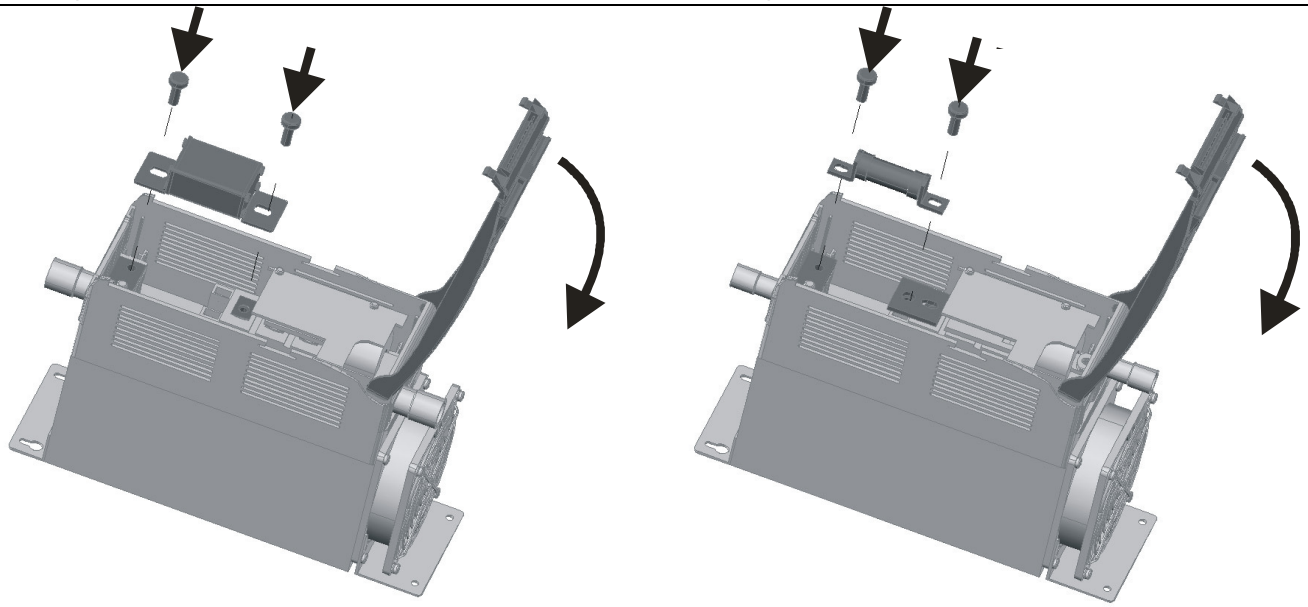
Caution: *High speed fuses are used only for the thyristor protection and can not be used to protect the installation.*

Caution: *The warranty of thyristor is null if no proper fuses are used. See tab.*

Warning: *When it is supply, the Thyristor unit is subject to dangerous voltage, don't open the Fuse-holder module and don't touch the electric equipments.*

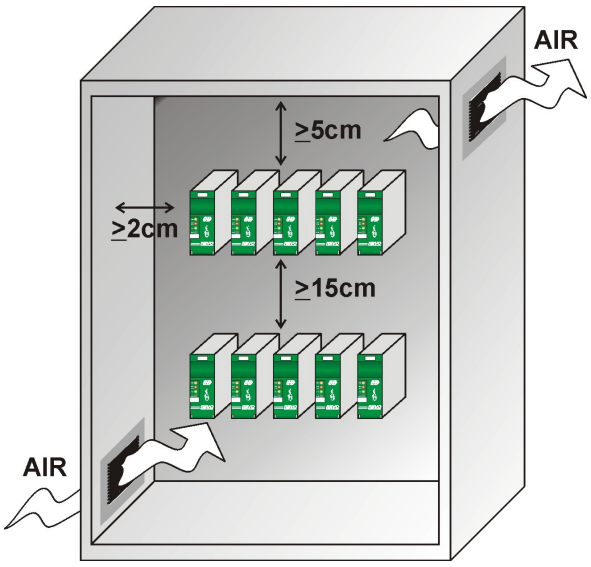
9.1 Fuses Replacement

Open the cover and remove the screws	Open the cover and remove the screws



10 Installation

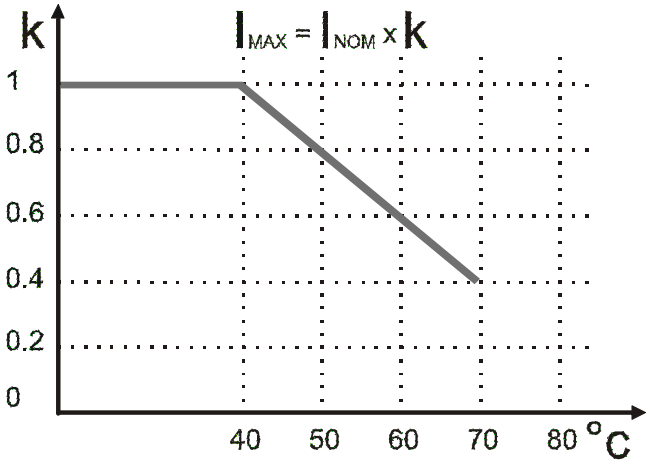
Before to install, make sure that the Thyristor unit have not damages.
If the product has a fault, please contact the dealer from which you purchased the product.
Verify that the product is the same thing as ordered.
The Thyristor unit must be always mounted in vertical position to improve air cooling on heat-sink.
Maintain the minimum distances in vertical and in horizontal as represented.
When more unit has mounted inside the cabinet maintain the air circulation like represented in figure.
Sometimes is necessary installing a fan to have better air circulation.



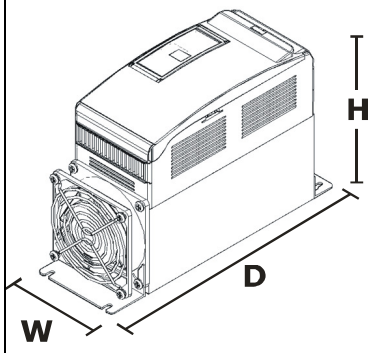
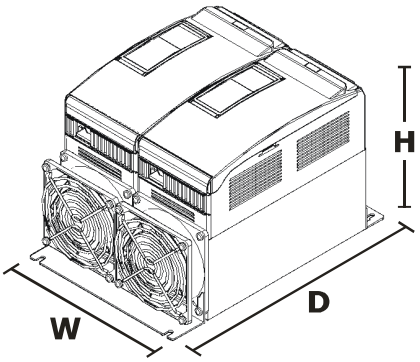
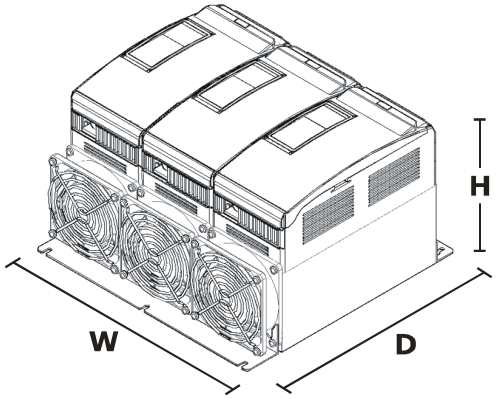
10.1 Environmental installation conditions

Ambient temperature	0-40°C at nominal current. Over 40°C use the derating curve.
Storage temperature	-25°C a 70°C
Installation place	Don't install at direct sun light, where there are conductive dust, corrosive gas, vibration or water and also in salty environmental.
Altitude	Up to 1000 meter over sea level. For higher altitude reduce the nominal current of 2% for each 100m over 1000m
Humidity	From 5 to 95% without condense and ice

10.2 Derating Curve

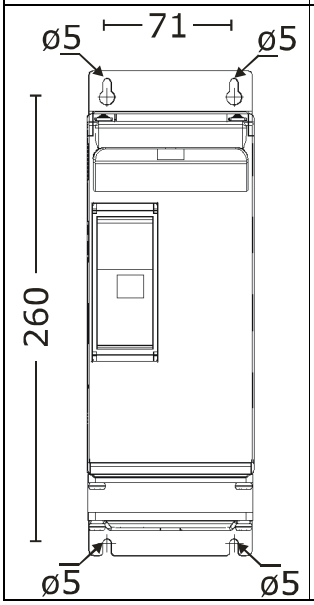
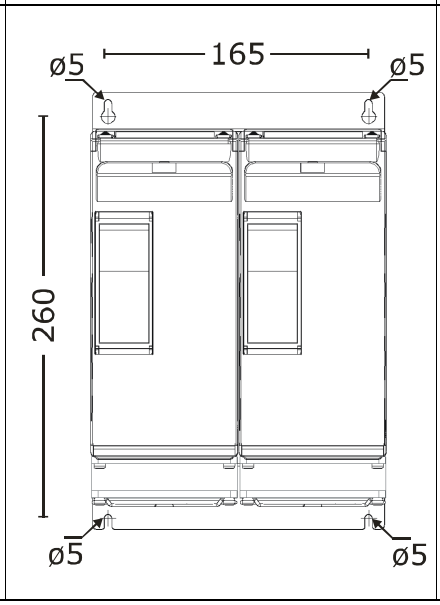
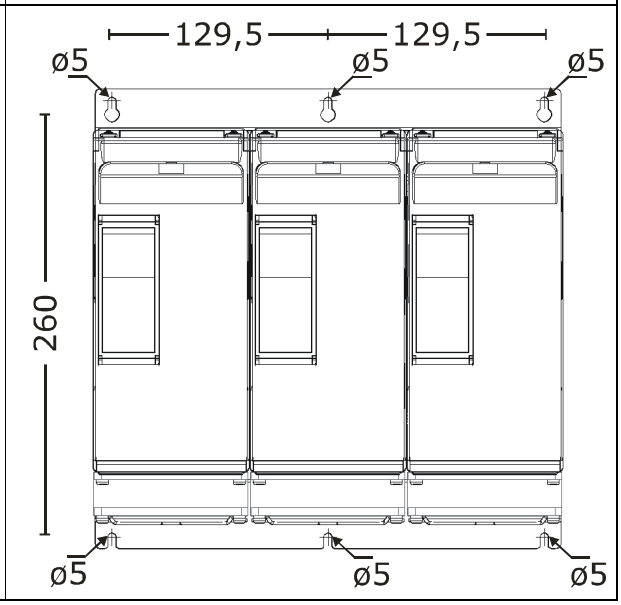


10.3 Dimensions and Weight

REVO M 1PH	REVO M 2PH	REVO M 3PH
		

Size	W(mm)	H(mm)	D(mm)	Weight (kg)
1PH	93	170	274	3,4
2PH	187	170	274	6,8
3PH	281	170	274	10,2

10.4 Fixing holes

REVO M 1PH	REVO M 2PH	REVO M 3PH
		

10.5 Technical Specifications

General features:	
Cover and Socket material:	PolymericV2
Auxiliary voltage:	90:130V 170:265V 230:345V 300:530V 510:690V
Relay output for Heater Break Alarm (only with HB option):	0.5A a 125VAC

Input features:	
Logic input SSR:	4 ÷ 30Vdc 5mA Max (ON ≥ 4Vdc OFF < 1Vdc)
Analogic input	0 ÷ 10Vdc impedance 15 K ohm
Analogic input	4 ÷ 20mA impedance 100 ohm
POT	15 K ohm min.
Digital Input	4 ÷ 24Vdc 5mA Max (ON ≥ 4Vdc OFF < 1Vdc)

Output features(power device):

Current	**Voltage range**	**Repetitive peak reverse voltage**		**Latching current**	**Max peak one cycle**	**Leakage current**	**I^2T value max**	**Frequency range**	**Power loss**	**Isolation Voltage**
(A)	**(V)**	**(480V)**	**(600V)**	**(mAeff)**	**(10msec.) (A)**	**(mAeff)**	**tp=10msec**	**(Hz)**	**I=Inom (W)**	**Vac**
60	24÷600	1200	1600	450	100	15	4750	47÷70	216	2500
90	24÷600	1200	1600	450	2000	15	19100	47÷70	324	2500
120	24÷600	1200	1600	450	1540	15	11300	47÷70	270	2500
150	24÷600	1200	1600	450	2000	15	19100	47÷70	324	2500
180	24÷600	1200	1600	300	4800	15	108000	47÷70	810	2500
210	24÷600	1200	1600	300	5250	15	128000	47÷70	1080	2500

11 Wiring instructions

The Thyristor unit could be susceptible to interferences lost by near equipments or by the power supply, for this reason in accord to the fundamental practices rules is opportune take some precautions:

- The coil contactor, the relays and other inductive loads must be equipped with opportune RC filter.
- Use shielded bipolar cables for all the input and output signals.
- The signal cables must not be near and parallel to the power cables.
- Local regulations regarding electrical installation should be rigidly observed.

Use copper cables and wires rated for use at 75°C only.

Power cable torque (suggested)

Type	Connector Type	Torque Lb-in (N-m)	Wire Range mm²(AWG)	MAX Current Terminals	Wire Terminals UL Listed (ZMVV)
060 090 120	Screw M6	70.8 (8.0)	1	150	Fork/Spade Terminal Copper Tube Crimp.Lug
150 180 210	Screw M8	265 (30.0)	1 3/0	250	Copper wire Compact (Solid) Stranded

Cable dimensions of the Command Terminals
0.5mm² (AWG 18)
Cable dimensions of the Earth (suggested)
16 mm² (AWG 6) up to 120A
25 mm² (AWG 4) up to 210A

Warning: *Before connecting or disconnecting the unit check that power and control cables are isolated from voltage sources.*

11.1 Power Terminals

Terminal	Description
L1	Line Input Phase 1
T1	Load Output Phase 1
L2	Line Input Phase 2 (only for 3pH)
T2	Load Output Phase 2 (only for 3pH)
L3	Line Input Phase 3 (only for 2Ph and 3Ph)
T3	Load Output Phase 3 (only for 2Ph and 3Ph)

11.2 Command Terminals

Warning: *Before connecting or disconnecting the unit check that power and control cables are isolated from voltage sources.*

11.2.1 Terminal block M1

Terminal	Description
1	GND
2	COM digital Input
3	Configurable Enable
4	Configurable Input1
5	Control Input +
6	Control Input -
7	+10V Output
8	Not connected
9	Common alarm relay output
10	Normally open\close alarm relay output
11	RS485 A
12	RS485 B

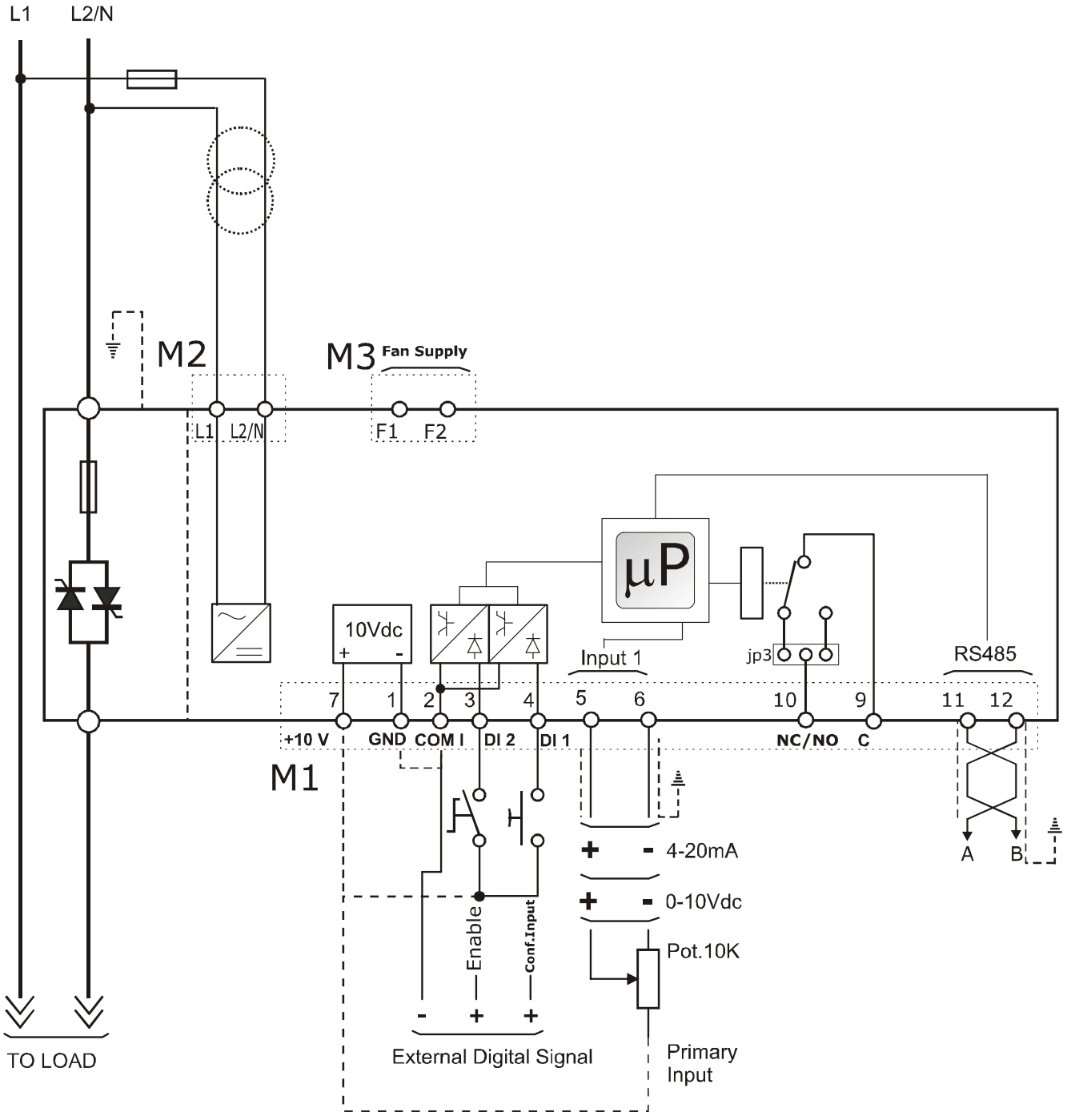
11.2.2 Terminal block M2

Terminal	Description
L1	Aux L1
-	Not Connected
L2/N	Aux L2/N

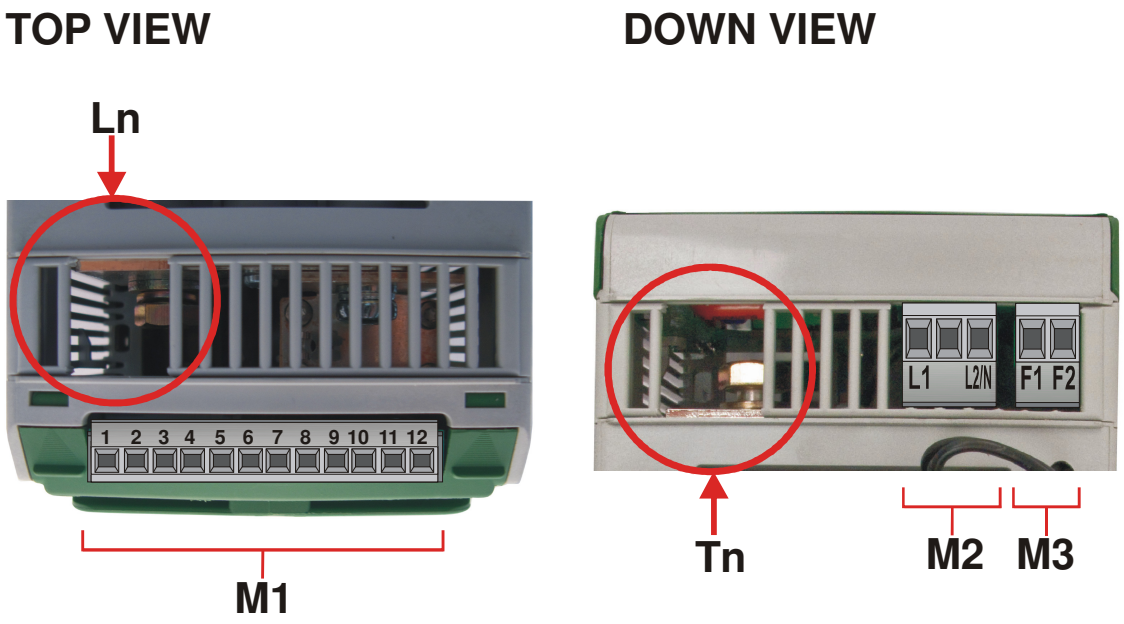
11.2.3 Terminal block M3

Terminal	Description
F1	Fan supply
F2	Fan supply

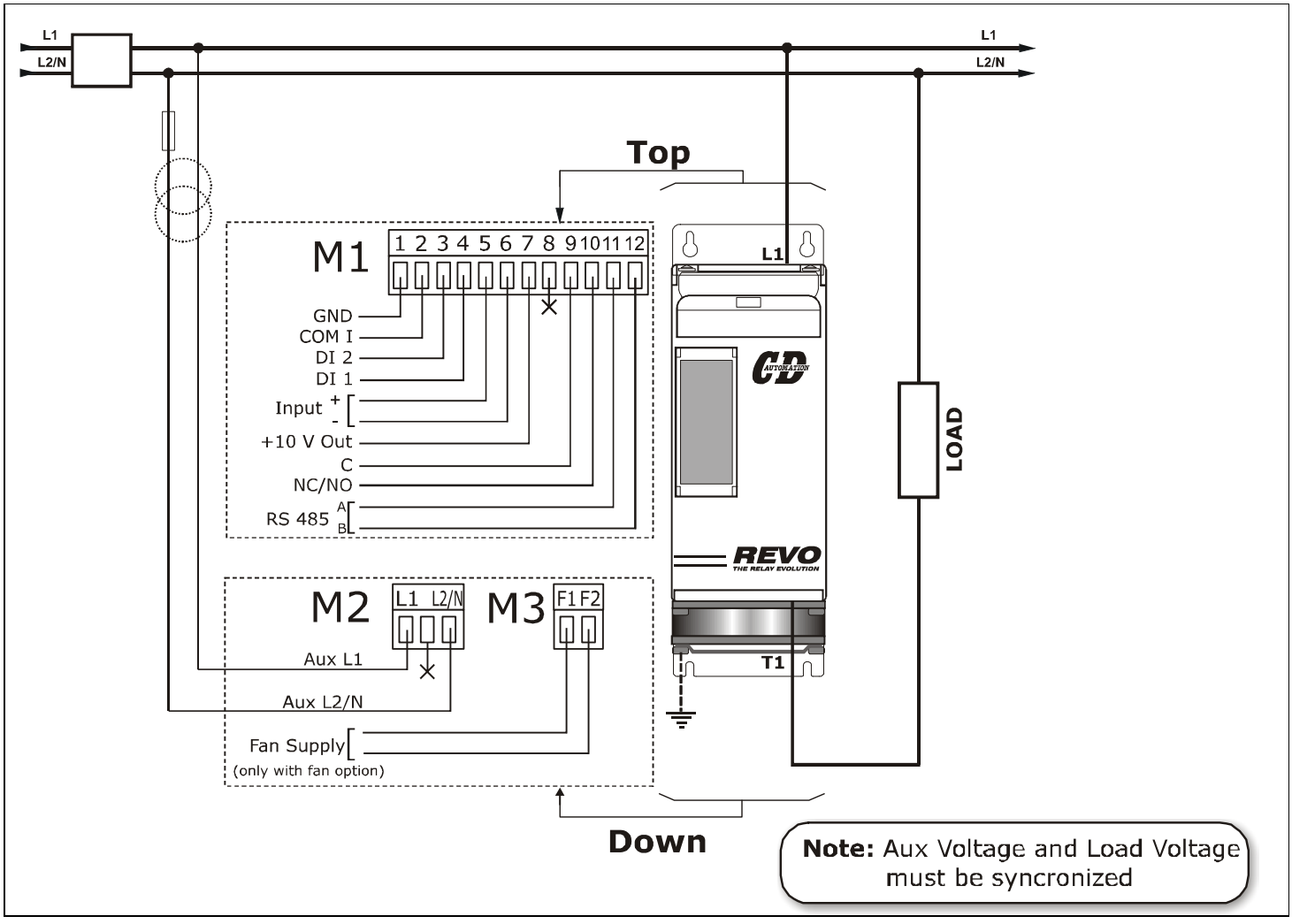
11.3 Schematic



11.4 Connection Diagram for Single-phase

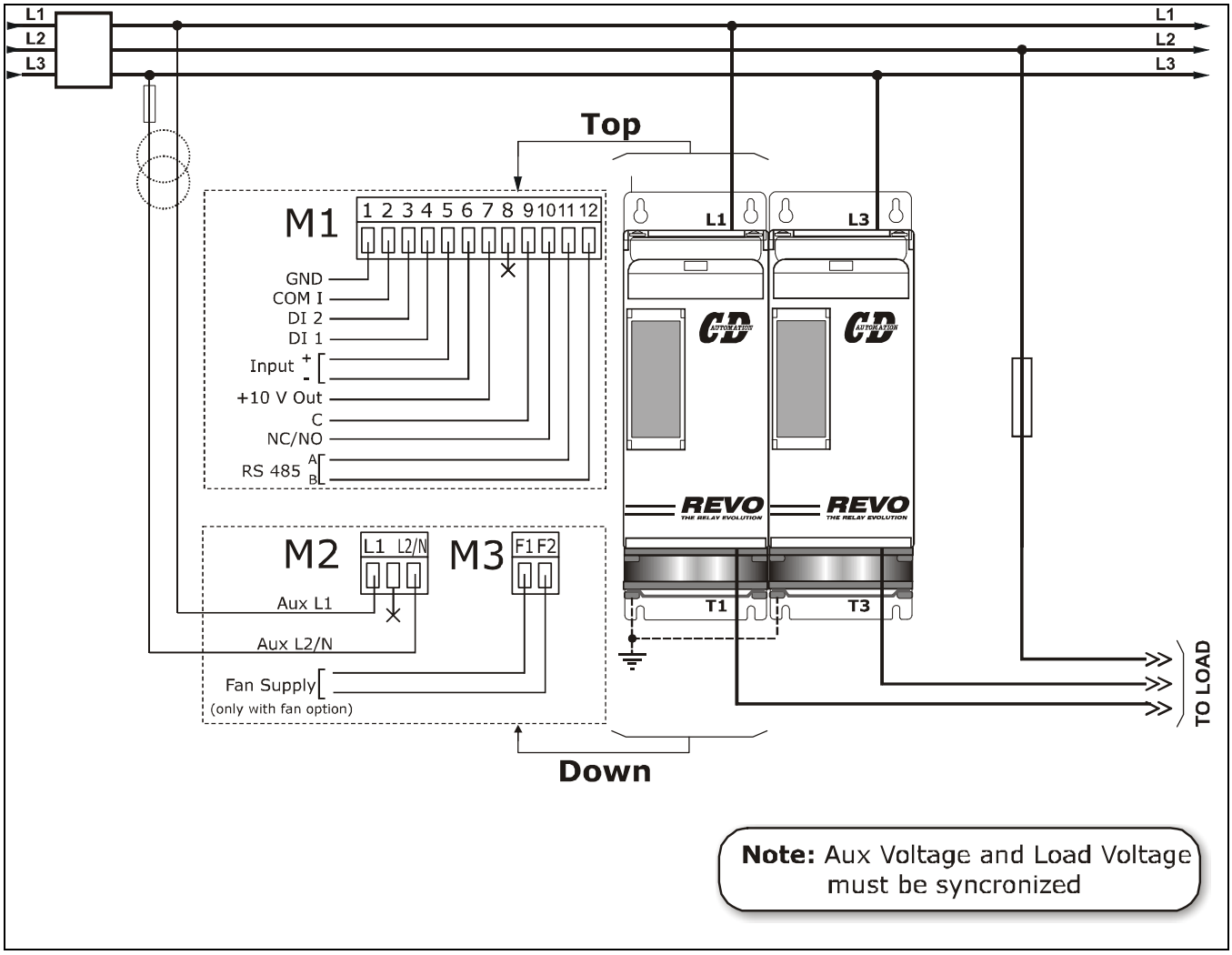


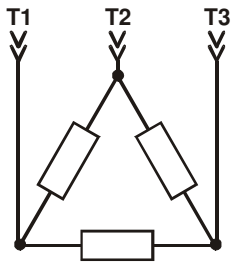
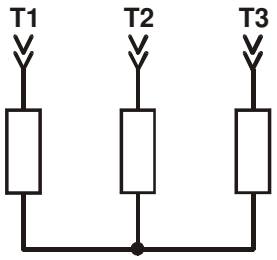
Caution: *this procedure must be performed only by qualified persons.*



11.5 Connection Diagram for 3 phases (control on 2 phases)

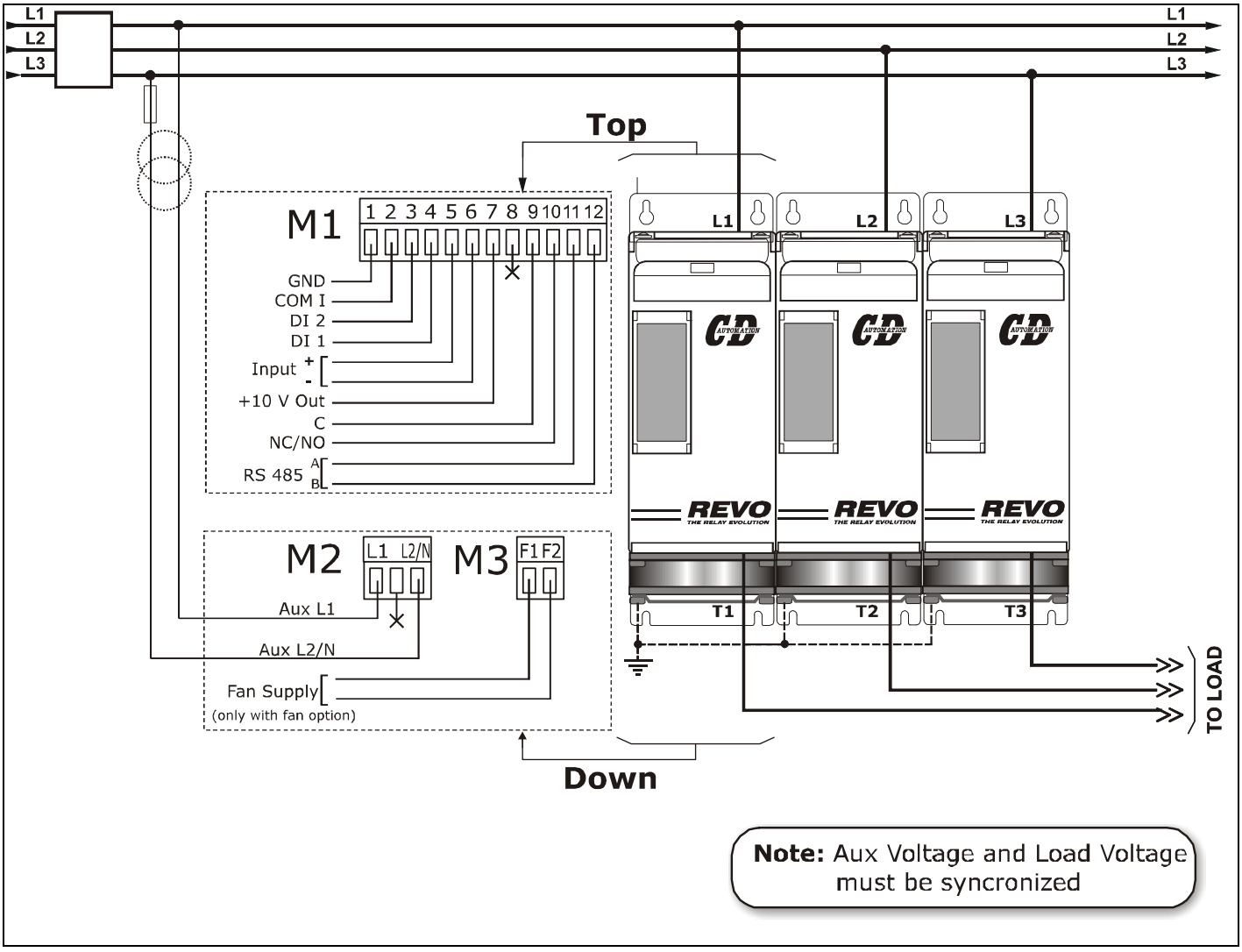
Caution: *this procedure must be performed only by qualified persons.*

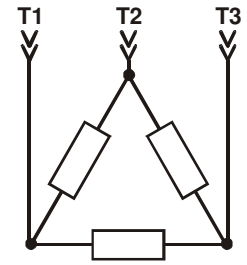
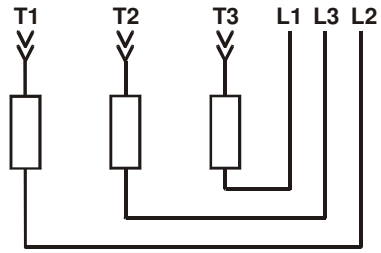
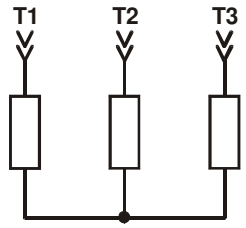
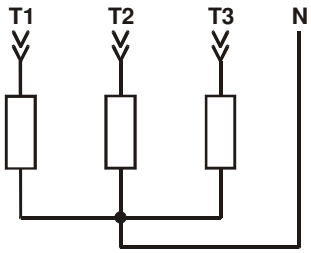


Load Type	
	
Delta	Star

11.6 Connection Diagram for 3 phases (control on 3 phases)

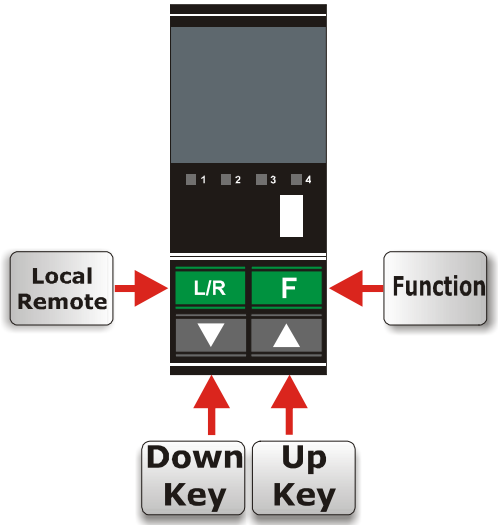
Caution: *this procedure must be performed only by qualified persons.*



Load Type			
			
Delta	Open Delta	Star	Star + Neutral

12 Control Panel

The Control Panel is placed on the front of the thyristor unit, on his display you can visualize the alarms, the input and output signals and all the configuration parameters .

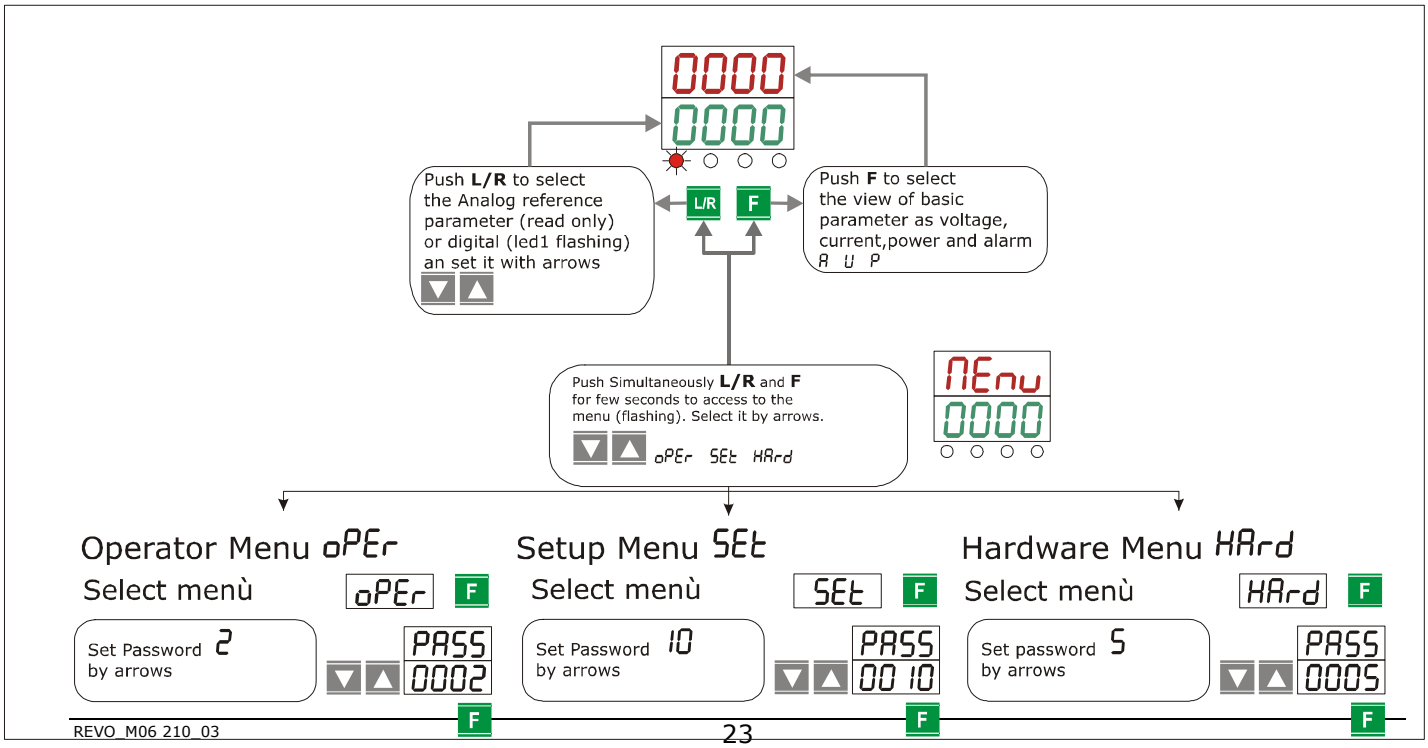


The function keys are the following:

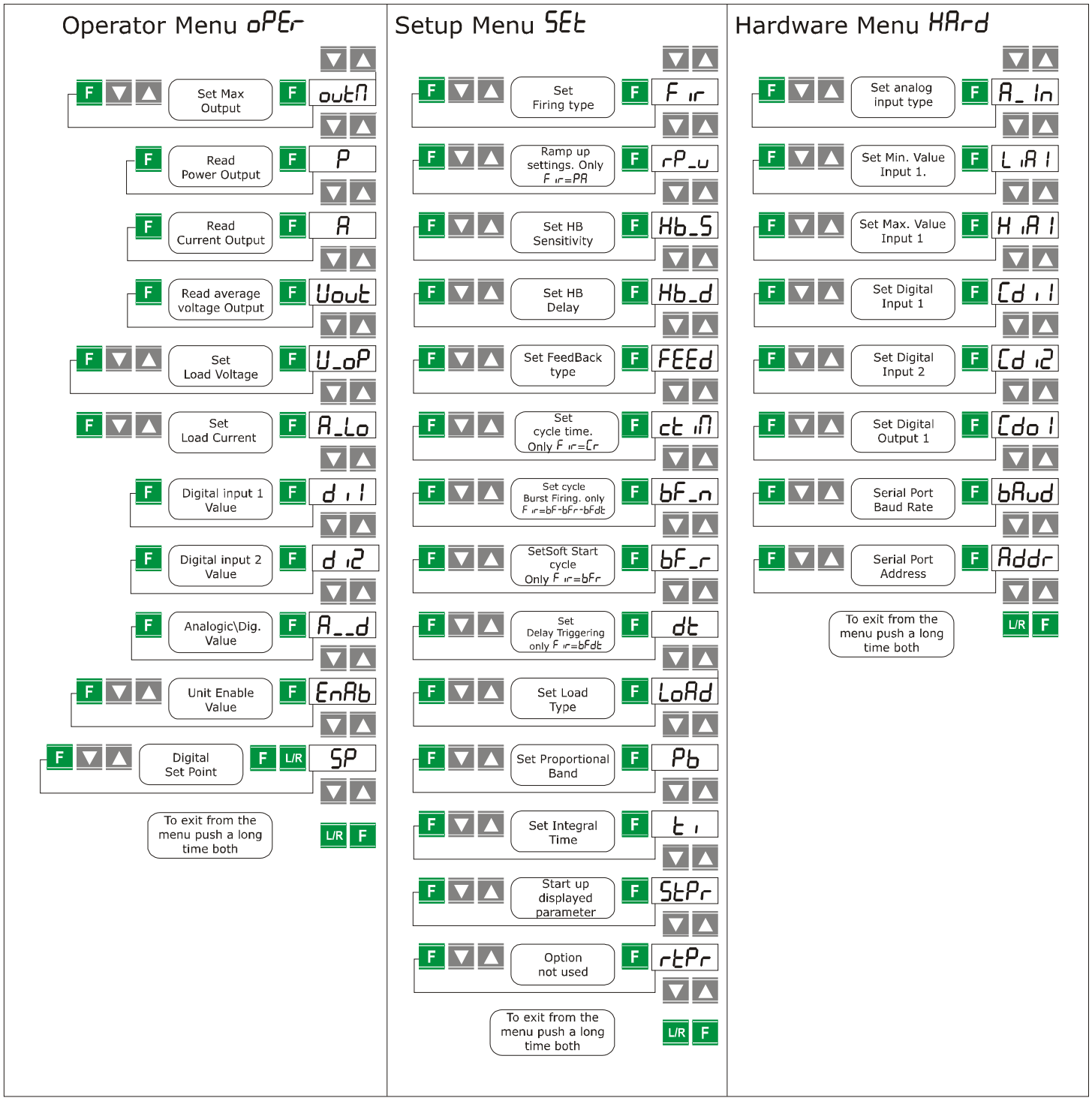
- The **Function key F** is used to scroll the parameter.
- The **UP key and DOWN key** are used to set the parameters in the menu and to change data.
- The **L/R key** is used to edit the parameters and to save the modified values.
- The **F+L/R** is used for enter and exit from the menu.

The Control Panel have three menu, and to enter in one of them you must set correctly the parameter PASS :

- Operator Menu (PASS = 2)
  This menù contains a reading parameters that give information on the state of the unit, it include also the base parameters for quick start, like the value of current and voltage load and the Set-point data.
- Hardware Menu (PASS = 5)
  This menu contains all the configuration parameters for analogic and digital I/O, and the parameters to set the serial port like the address and the baudrate.
- Setup Menu (PASS = 10)
  This menù contains all the setting parameters to configure the thyristor unit, like the firing type, the current limit, [ecc].



12.1 Scroll the parameters



13 Input output signal

13.1 Digital Input

The REVO M thyristor unit has 2 digital inputs opto-isolated to 24Vdc 5 mA.
You can activate the inputs with the internal supply or with an external source for example the PLC.

13.1.1 Start/Stop (Terminal 3 of M1)

This is the start command (Enable) of the REVO M.
If you Remove the Start command the REVO M thyristor unit will be stopped and the output will return at zero.

13.1.2 Configurable Input (Terminal 4 of M1)

This digital input is configured by the parameter Cd.I and could perform different functions:

- Enable:
  This function forces the output at zero.
- Feed-Back Selection:
  With this function, when you active the input, the feed-back setted in the parameter FEEd change in Voltage Feed-Back (V).
- Analog/Digital Setpoint(Local/Remote:
  With this function, when you active the input, the setpoint reference change from Analog input to Digital value, setted in the parameter SP .
- Change Firing type:
  With this function, when you active the input, the Firing type setted in the parameter F.Fr change in Phase Angle PA (available only on 1PH).

13.2 Digital Output (terminal 9-10 of M1)

The REVO M thyristor unit has 1 relay output on terminal 9-10 of terminal block M1(Max 500mA, 125Vac). The functionality of this output cane be setted with the parameter Co.I
This digital output can be configured in order to activate itself after that one of these alarms occours:

- HB and SC alarm are active.
- Only HB alarm is active.
- Only SC alarm is active.

13.3 Analog Input

Primary Input (Terminals 5 and 6 of M1)

The REVO M thyristor unit has 1 analog inputs (0÷10V, 0÷20mA, 4÷20mA ecc):
The primary input for the analog setpoint.

The primary input is already configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label.
However, if you wish to change the primary input (ex. from 0÷10V to 0÷20mA, 4÷20mA).

14 Heater Break alarm and SCR short circuit (HB Option)

Caution: *to work properly the load must be powered at least about 160msec.*

The Heater Break circuit read the load resistance with an Internal voltage transducer and Internal current transformer (C.T.), to calcolate the resistance (V/I).
Minimum current is 10% of the current transformer size.
If load current is below this value the Heater Break Alarm doesn't work properly.

14.1 Heater break Calibration procedure

An automatic function sets the Heater Break Alarm.
Write in the parameter **A_Lo** and **U_oP**
If load current decreases for partial or total load failure (sensitivity 20%) HB alarm become ON and alarm relay change status.
If the unit is still in conduction with no input signal (LED green OFF) it means that there is a short circuit on thyristors and (SC) become ON.

You can Adjust the sensibility of HB alarm by using the parameter **Hb_S** This parameter is setted between 1 and 255% of the nominal resistance.
This parameter is the maximum reduction of the resistance Load to establish the HB Alarm.

There is also **HB_d** parameter to set a delay to have HB alarm active.

14.2 HB alarm contact (digital output)

The Revo unit with HB option, is supplied with Heater Break alarm contact normally opened (NO):

- In normal conditions (without alarm) and with auxiliary power supply, the contact to the terminals has opened (relay coil energized).
- In alarm condition or without auxiliary power supply the contact to the terminals is closed (relay coil not energized).

This alarm can be configured in order to activate itself after that one of these alarms occours:

- HB and SC alarm are active.
- Only HB alarm is active.
- Only SC alarm is active.
- Disable the relay output.

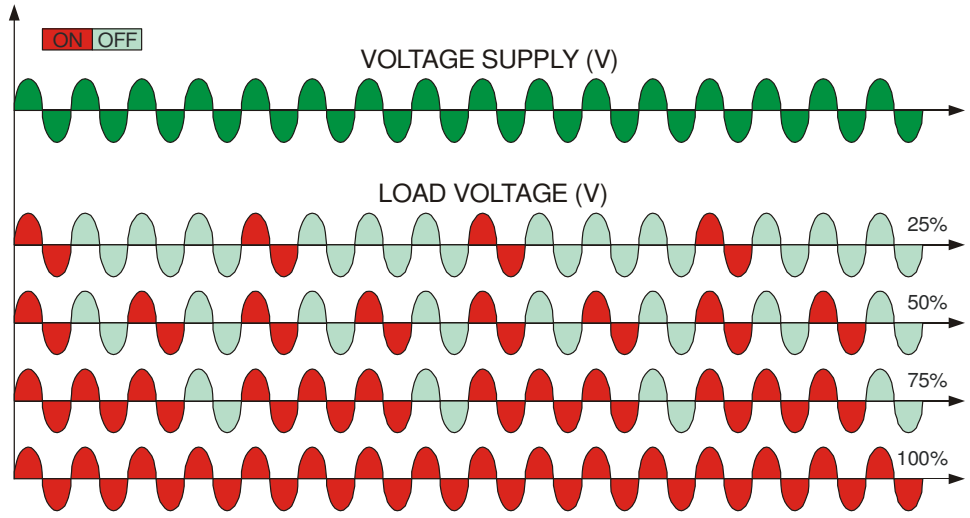
15 Firing type

Choose an correct firing type allows to optimize the thyristor unit for the installed load.
The firing type has already configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label.
However, if you wish to change the firing type you can use the software configurator or the Control Panel.

Caution: *this procedure must be performed only by qualified persons.*

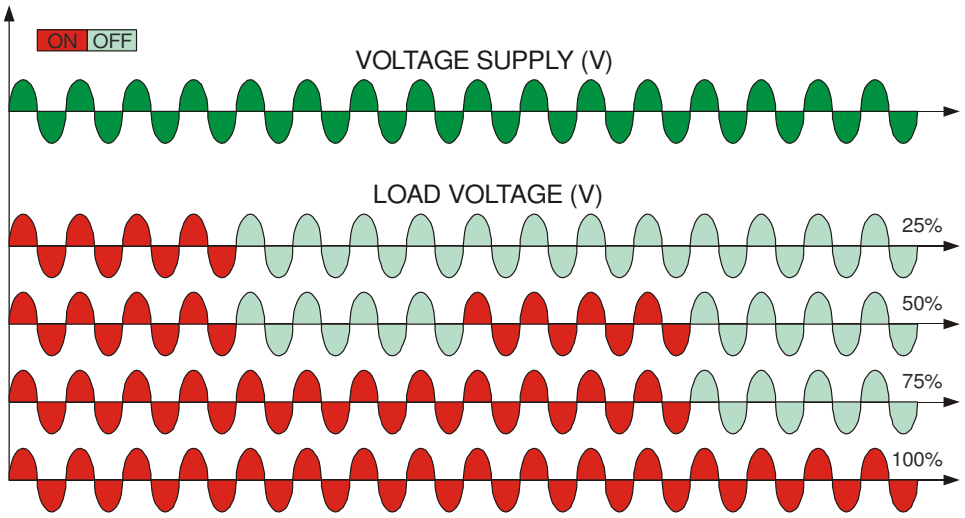
15.1 Single Cycle SC (1Ph Only)

Single Cycle it's the faster zero crossing switching method in relationship of the power demand from a temperature regulator or from an external signal.
With input signal at 25% the output is one cycle ON and three cycles OFF
With input signal at 50% the output is one cycle ON and one cycle OFF
With input signal at 75% the output is three cycles ON and one cycle OFF
With input signal at 76% the output is the same of 75% but for each ON cycle the microprocessor divides 76/75, and when the sum of rests is one, the unit does one more cycle ON. For this firing is necessary to have analog input.
The Single Cycle is used to control the loads with low inertia or for infrared lamps to short wave.



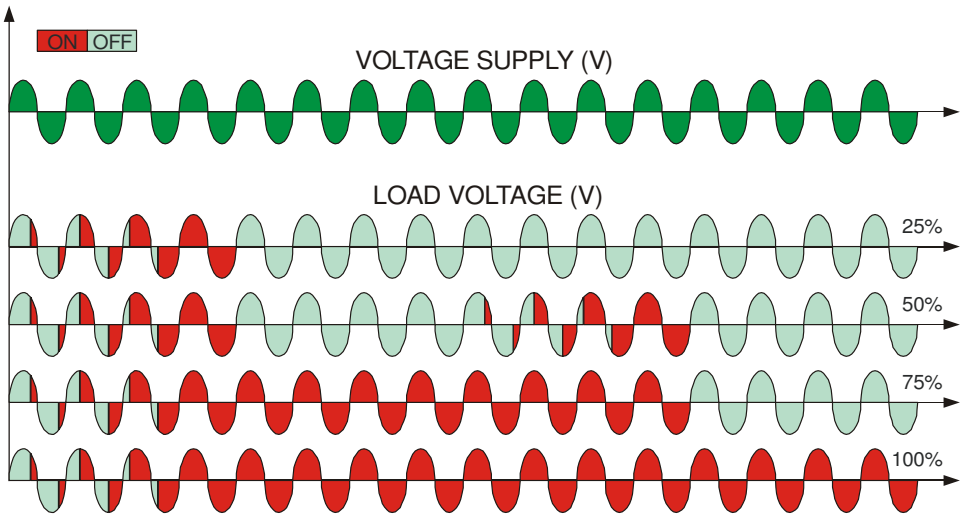
15.2 Burst Firing (BF)

The Burst Firing is similar to the Single Cycle, but consecutive cycles ON are selectable between 2 and 255, with input signal equal at 50%.
Burst Firing is a method zero crossing that it reduces the electromagnetic interferences because the thyristor switches at zero voltage crossing.
The example show the Burst Firing with Burst cycles: bF_n =4



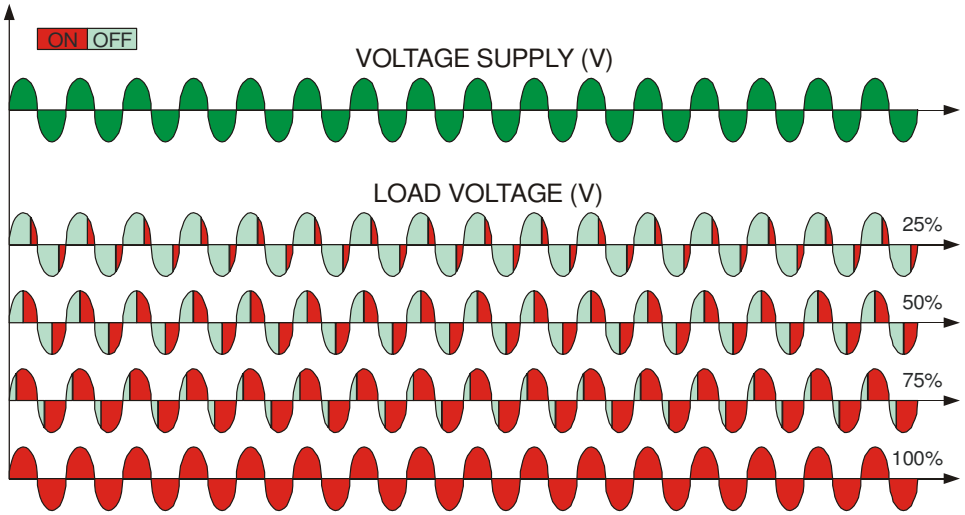
15.3 Soft Start with Burst Firing S+BF (1Ph Only)

This is an additional function to the Burst Firing. The unit start in phase angle mode with a ramp starting from zero up to the full tension in the cycles number set in the parameter bF_r.
When the ramp is over, the thyristor unit will stay in conduction at full voltage up to the end of cycles of burst. The S+BF firing is used to control small inductive loads to avoid inrush surge current and to reduce the electromagnetic interferences.
The example show the firing with Burst cycles: bF_n =4 and ramp cycles: bF_r =3



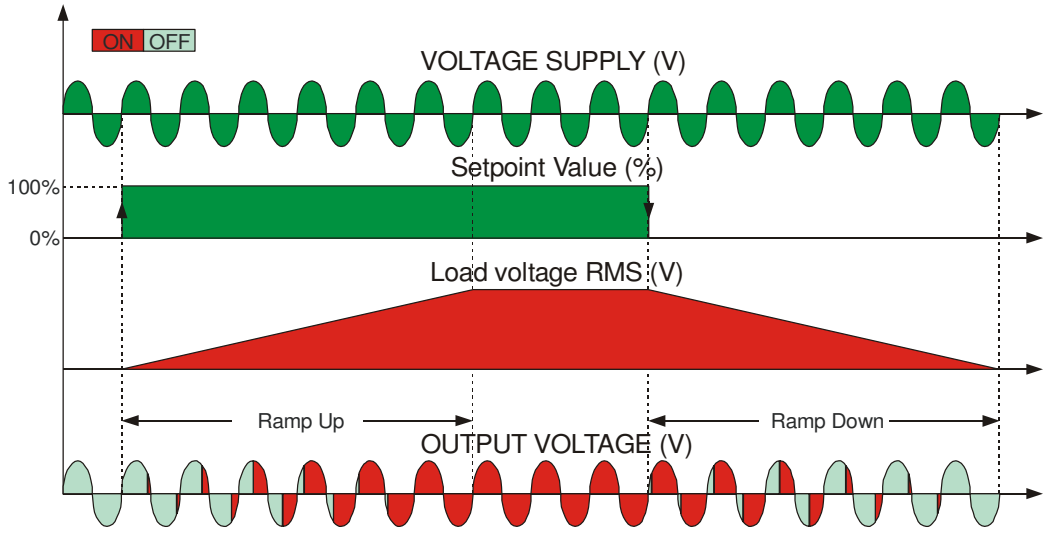
15.4 Phase Angle PA (1Ph Only)

The Phase Angle firing allow the control of the power on the load, for this firing the thyristor can be in conduction only for a part of the voltage cycle.
This part of the voltage cycle is adjustable in function of the input signal from 0 at 100%.
The PA firing is normally used for control the inductive loads, and is also possible control a primary of transformer coupled with the cold resistances like: Superkanthal, Molybdenum, Platinum, Tungsten or Quartz Lamp. The only disadvantage with phase angle is the possible generation of interferences that however can be reduced with opportune filters.



15.5 Soft Start with Phase Angle (S+PA)

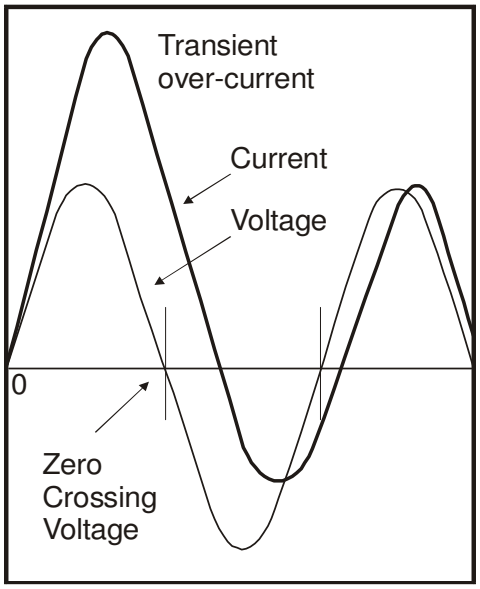
This is an additional function to the Phase Angle. The firing angle of the thyristor increase or decrease up to the final setpoint value.
The Soft start ramp is an important feature to reduce the inrush current with transformers during the during the cycle of magnetization or with cold resistance that are near to the short circuit when they are supplied.
Setpoint Ramp Up : rP_u
Setpoint Ramp Down: rP_d



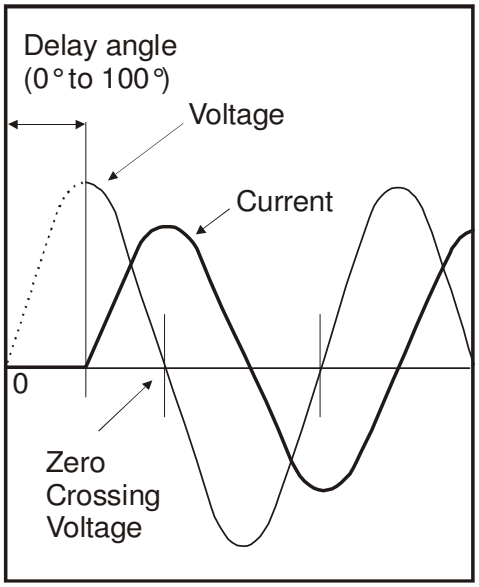
15.6 Delay Triggering DT (1Ph Only)

The Delay Triggering firing is used the control a primary of transformer coupled with the normal resistances on the secondary (N.B. don't connect cold resistances on the secondary like: Superkanthal, Molybdenum, Platinum, Tungsten, Quartz Lamp).
For an inductive load (ex transformer), switching the thyristors at zero crossing can generates transient over currents that can blow the fuses, to avoid this problem you must use the Delay Triggering. This firing delay the first half cycle of Burst for an angle from 0 to 100° relative to the zero, besides all the first burst start with soft start ramp to reduce the inrush current during the cycle of magnetization.

Without Delay Triggering

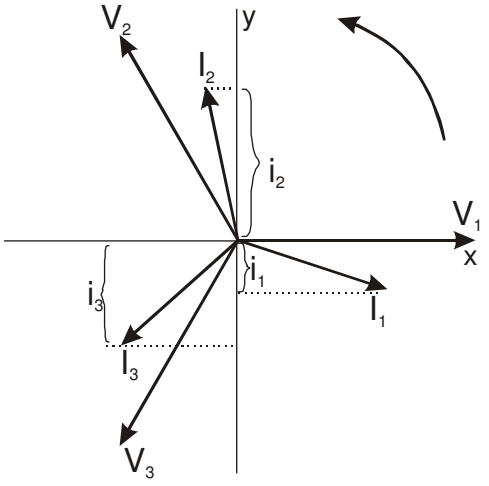


With Delay Triggering

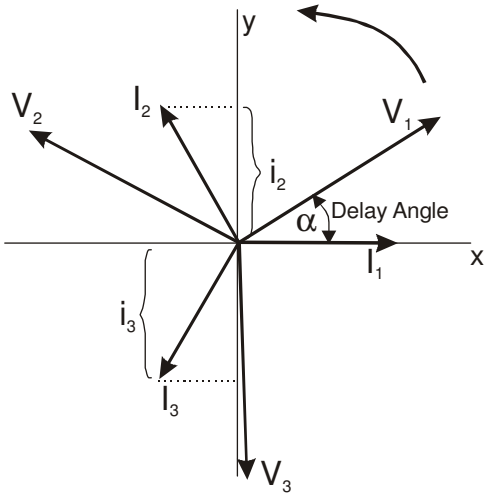


For understand the Delay Triggering firing, we have represented the waves generate by vectors that rotates in counterclockwise:

Without Delay Triggering



With Delay Triggering



Without delay at zero crossing when V1 is to zero (projected on the X axis) the unit switch On.
In this case the instantaneous value of the currents are i1, i2 and i3 and this condition, for the curve of magnetization, could generate transient over currents that can blow the fuses.
With Delay Triggering the firing of the thyristor are triggered with a delay until the instantaneous value of the curret i1=0, i2 positive and i3 negative like represented.
In this case the risk of transient over currents is reduced and the fuses don't blow.
The angle alpha is the delay to have i1=0 and this angle depends on the power factor.
The delay angle suggest for most applications is 80°

16 Feed-back type

The Feed-back type has already configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label.
However, if you wish to change the Feed-back type you can use the software configurator or the Control Panel.

Caution: *this procedure must be performed only by qualified persons.*

The Feed-back type is defined by the parameter FEEd .
If the configurable digital input has set like Feed-Back Selection , it's possible to change the select Feed-Back with the Voltage Feed-Back (V) simply activating the input.
The feed-back defines the Control Mode. It's possible to have:

- V=Voltage feed-back.
  The input signal is proportional to the output voltage. This means that input signal becomes a voltage demand. This control mode compensates the voltage fluctuation of the incoming line supply.

- I=Current feed-back.
  The input signal is proportional to the current output. This means that input signal becomes a current demand. This control mode maintain the current also if the load impedance changes.

- W=Power feed-back.
  The input signal is proportional to the power output. This means that input signal becomes a power demand. The power remains constant also if voltage and load impedance change. This control mode is used with silicon carbide elements that change its resistive value with temperature and with age. In addition it compensates the voltage fluctuation of the incoming line supply.

- V2=Square Voltage feed-back.
  The input signal is proportional to the output square voltage. This means that input signal becomes a power demand. The power remains constant if the load impedance doesn't change.

- NO=No Feedback Open Loop. The input is proportional to the firing angle (α).

17 Analog Inputs

The REVO M thyristor unit has 2 configurable analog inputs (0÷10V, 4÷20mA, ecc):
The primary input for the analog setpoint, the secondary input for the Current Profiler or Ext. Feed-Back.

Primary Input (Terminals 5 and 6 of M1)

The primary input is already configured in line with customer requirements that are defined in the Order Code. The Order Code is written on the identification label.
However, if you wish to change the primary input (ex. from 0÷10V to 4÷20mA) proceed as follows:

Primary Input calibration procedure

When you change the hardware setting is necessary make the Input calibration procedure.
To make the Input calibration procedure follow these steps:

- Give the power supply.
- With Control Panel go in the Hardware menu (PASS = 5)
- Set the input signal to the min value (ex. 0V for 0÷10V or 4mA for 4÷20mA)
- Set the parameter L.AI = 1
- Press ENTER key
- Set the input signal to the max value (ex.10V for 0÷10V or 20mA for 4÷20mA)
- Set the parameter H.AI = 1
- Press ENTER key

The Input calibration procedure is done.

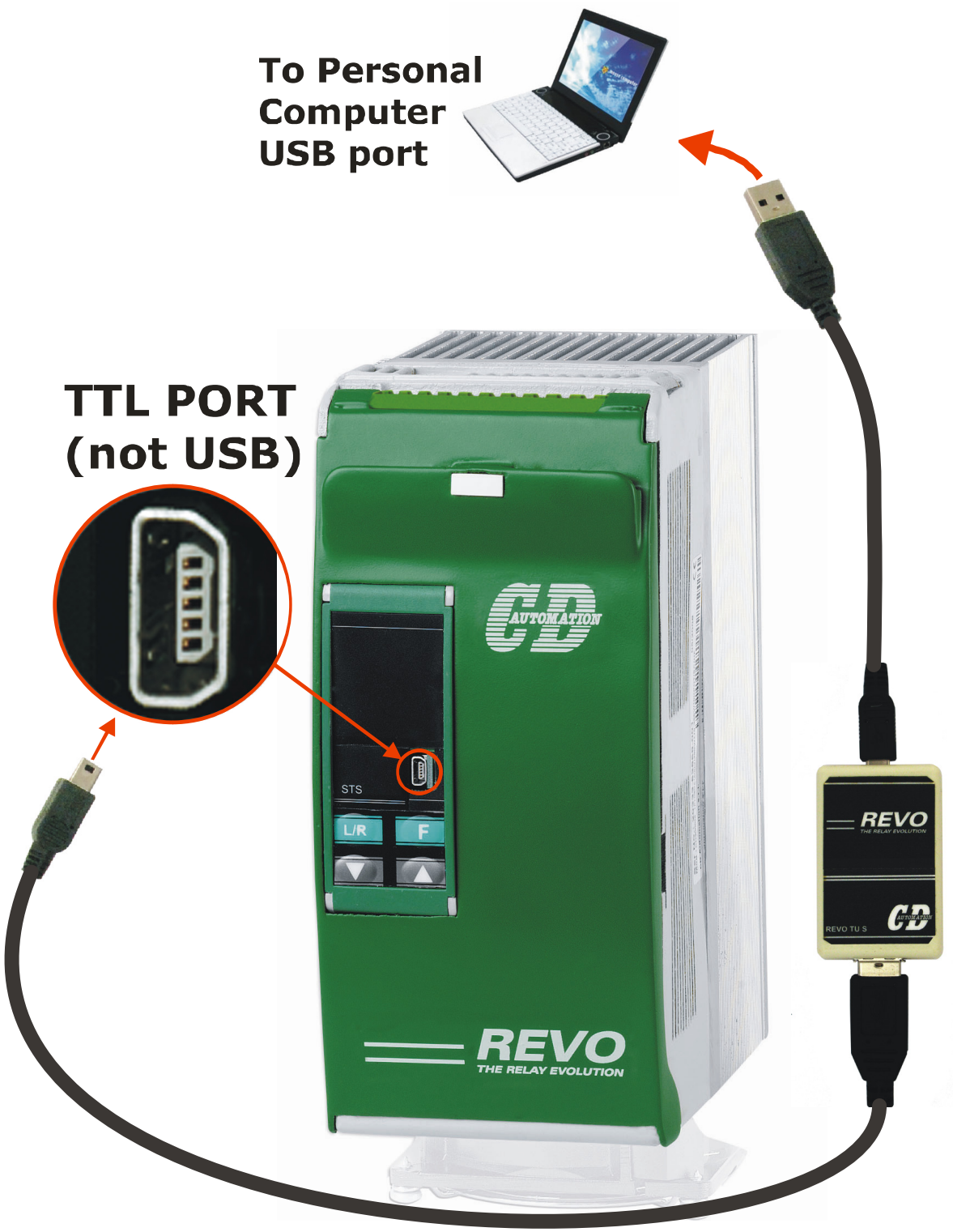
18 RS485 Serial Port

The serial communication port RS485 is available on the Command Terminals and on the 9pin DIN male connector.
On this port may be done a network up to 127 REVO M.
On the 9pin DIN male connector is also possible connect the CD-EASY

Terminal M1	Description
11	RS485 A
12	RS485 B

19 PG Connector

The PG Connector is used to configure the thyristor unit with the configuration software and with the programming cable.
The programming cable is not included.



20 MODBUS communication

The serial communication port of the thyristor unit is two-wire RS485 type.
This port use an half-duplex system.
When a Unit must transmit active the transmission line, and when there are not units in transmission the outputs are fixed to high impedance.
The serial communication port allows to communicate between the thyristor units and a MASTER device (ex. an computer or a terminal). The cable must be rated for use to data transfer

20.1 MODBUS RTU Protocol

The communication is based on the standard industrial MODBUS RTU with the following restrictions:

- The Baud rate can be 4800-9600-19200 Baud (Standard 19200).
- The Preset Multiple Registers (Funct. 16) is limited to the writing of a single parameter for message.

The following MODBUS functions are supported:

Function	Description
03	Read Holding Registers
16	Preset Multiple Registers

The unit support the Broadcast messages:
It' possible send a Broadcast messages using the address 0, all the units respond at the message without sending back any reply.

20.2 Message Format

The transmission format is a 1 bit start, 8 date bit, and 1 bit stop with no parity verification.
Each message terminate after a said time of "time out", equal at 3.5 time of a character transmission, where there are not transitions on the transmission line.
The first Byte of each message is always the address of the unit that is a value from 1 to 255 or 0 for the broadcast messages, the second is always the function number, and the rest of the message depends of the function demand.

When a Slave receive an message, the unit send an answer with the same structure but with the information demanded.

Each message is followed by CRC (Cyclic Redundancy Check) with two byte. The CRC identify the incongruity situations of the message, in this case the receiver ignore the message.
The CRC is calculated in accordance with a formula that imply a recursive division of the data by a polynomial.
The polynomial divisor is:
$2^{16} + 2^{15} + 2^2 + 1$(Hex 18005)
but is modified in two ways:

- Since the bits order are reversed, then the binary pattern is also reversed, and the most significant bit (MSB) is the right-most bit.
- Since interest only the remainder, the right-most bit could be discarded.

Therefore, the polynomial divisor has value: Hex A001

Normal bit order:

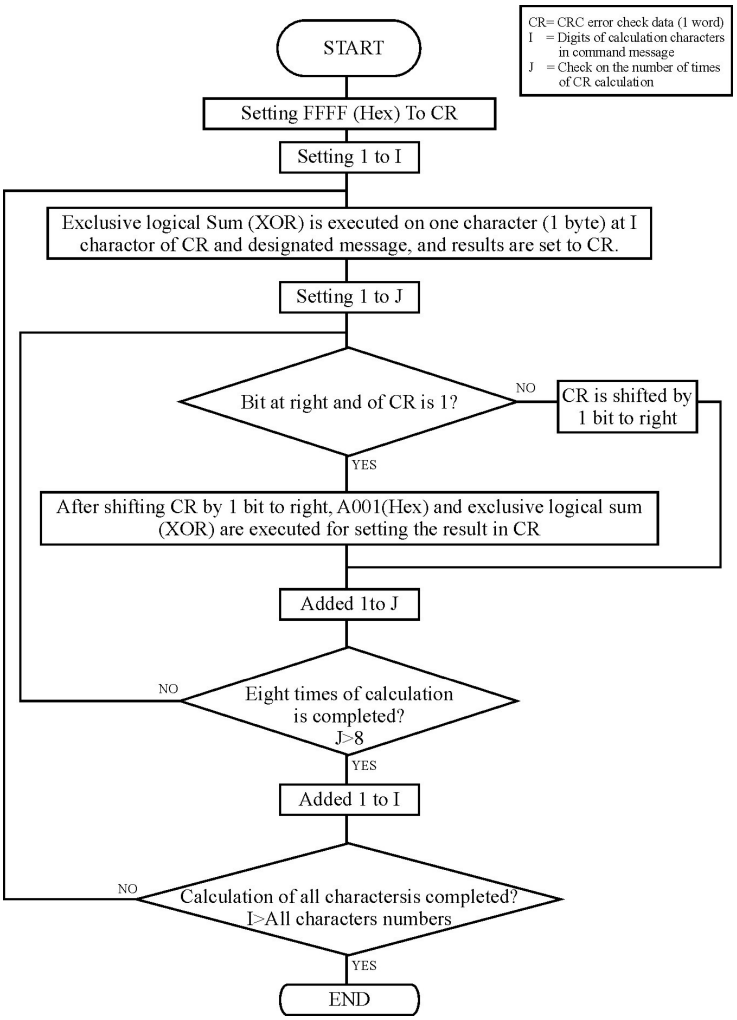
Most significant bit																Least significant bit
	Most significant Byte								Least significant Byte							

Reversed bit order:

Least significant bit																Most significant bit
	Least significant Byte								Most significant Byte							

N.B.: With the reversed bit order, also the CRC16 returns the with the reversed bit order

The following flow-diagram show how to organize the CRC 16 bit.


CR= CRC error check data (1 word)
I = Digits of calculation characters in command message
J = Check on the number of times of CR calculation
START
Setting FFFF (Hex) To CR
Setting 1 to I
Exclusive logical Sum (XOR) is executed on one character (1 byte) at I charactor of CR and designated message, and results are set to CR.
Setting 1 to J
Bit at right and of CR is 1?
NO
CR is shifted by 1 bit to right
YES
After shifting CR by 1 bit to right, A001(Hex) and exclusive logical sum (XOR) are executed for setting the result in CR
Added 1to J
NO
Eight times of calculation is completed? J>8
YES
Added 1 to I
NO
Calculation of all charactersis completed? I>All characters numbers
YES
END

C Language CRC 16 Example

```
static short CRC16 (unsigned char *p_first,unsigned char *p_last)
{
        unsigned int crc=0xffff;
        short j;
        for (;p_first<=p_last;p_first++)
        {
                crc ^= *p_first;
                for(j=8;j>0;j--)
                {
                if(crc & 0x0001)
                        {
                        crc = crc >> 1;
                        crc ^= 0xA001;
                        }
                 else
                        {
                        crc = crc >> 1;
                        }
                }
        }
  return (crc);
}
```

20.3 Read Holding Registers

This function reads the instantaneous value of a specified number of parameters from an address.
The message is composed by 8 Byte: one Byte is for the address, one for the function (03 Hex), two Byte for the first parameter to read, two Byte for the total number of parameters to read and finally two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		CRC 16	
	3 3Hex	HI	LO	HI	LO	LO	HI

The answer is an echo of the first two Byte (address and function), one byte with the number of following byte to exclusion of the CRC, the demanded values and finally two Byte for the CRC:

Address Unit	Function	N° of Byte	First Parameter Value			Last parameter value		CRC 16	
	3 3Hex		HI	LO	…	HI	LO	LO	HI

20.4 Preset Multiple Registers

This function could write only a parameter for each message.
The message is composed by 11 Byte: one Byte for the address, one for the function (10 Hex), two Byte for first parameter to write, two Bytes for the N° of parameters, fixed to 1 (0001 Hex), one Byte with the number of following Bytes, fixed to 2 (02 Hex), two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		N° of Byte	Value to write		CRC 16	
	16 10Hex	HI	LO	0	1	2	HI	LO	LO	HI

The answer is an echo of the first two Byte (address and function), two Byte for first written parameter, two Byte with the N° of parameters, fixed to 1 (0001 Hex), two Byte for the CRC:

Address Unit	Function	Address of the First Parameter		N° of the Parameter		CRC 16	
	16 10Hex	HI	LO	0	1	LO	HI

20.5 Error and exception responses

If a message contains an altered character, if fails the CRC, or if the received message contains a syntax error (for example the number of the byte or of the words is not correct), then the unit will ignore the message.

If the received message is correct but contains a not valid value, the unit will send an answer of exception (5 byte):

Address Unit	Function	Error Code	CRC 16	
			LO	HI

The byte with the function number, represent the function number of the message that has caused the error with the first Bit set to 1 (ex. the function 3 becomes 0x83) The error code could be one of the followings:

Error Code	Name	Cause
1	ILLEGAL FUNCTION	Function not supported.
2	ILLEGAL DATA ADDRESS	Address out of range.
3	ILLEGAL DATA VALUE	Attempt to write invalid or action not carried out.

NOTE: If you write a parameter's value equal at his actual value this is a valid transaction and don't cause an error.

20.6 Address Configuration

The thyristor unit is assigned a unique device address by the user in the range 1 (default) to 127 using the parameter P115 Addr in the Hardware menu. This address is used to recognise the messages queries to her assigned.
The thyristor unit does not respond at the messages queries that don't have the same assigned address.

The thyristor unit will also accept global messages (Broadcast) sends at the address 0. No responses are returned for globally addressed queries.

21 Configuration Parameters

The Configuration Parameters are accessible from the Control Panel (place in front of unit), from the software configurator or through the serial communication port RS485.
With the RS485 Serial Port the parameters are not divided by menu, but only by numerical order.

P010 (H0A) Uout **Average voltage output** **V** **R**
Function: This parameter show the Average voltage output on the three phases.
Min/Max: 0 ÷ 1023 (0 ÷ 3FF Hex)
Value: from 0 = 0V,
To 1023 =1023V.
Default: -
Example: 220V is equal to read value 220
Note: -

P011 (H0B) A **Current output** **A** **R**
Function: This parameter shows the RMS current present on the power terminal L1.
Min/Max: 0 ÷ 1023 (0 ÷ 3FF Hex)
Value: from 0 = 0A,
To 1023 =102,3 A. for unit up to 90A

from 0 = 0A,
To 1023 =1023A.
Default: -
Example: 45A is equal to read value 450 with decimal point P040 settings = 1
450A is equal to read value 450 with decimal point P040 settings = 0
Note: -

P012 (H0C) P **Power output** **%** **R**
Function: This parameter shows the Average power output on the three phases.
Min/Max: 0 ÷ 1023 (0 ÷ 3FF Hex)
Value: from 0 = 0%,
To 1023 =100%.
Default: -
Example: -
Note: -

P013(H0D) **Status Table** **R**
Function: It's a tab in bit that represent the "Status" of thyristor unit
Value: Bit 0 = 1 -> Short circuit on SCR
= 0 -> NO short circuit on SCR
Bit 1 = 1 -> Load Failure (HB Alarm)
= 0 -> NO Load Failure (HB Alarm)
Bit 2 = 1 -> Output signal ON
= 0 -> Output signal Off
Bit 3 = 1 -> HB Calibration in progress
= 0 -> NO HB Calibration in progress
Bit 4 = not used.
Bit 5 = 1 -> Heat sink over temperature
= 0 -> NO HB Heat sink over temperature
Bit 6 = not used
Bit 7 = not used
d.1 Bit 8 = 1 -> Digital input 1 closed
= 0 -> Digital input 1 open
d.2 Bit 9 = 1 Digital input 2 closed
= 0 -> Digital input 2 open

P014 (H0E) **Command Table** **R/W**

Function: It's a tab in bit for remote commands via RS485
Value: Bit 0 = 0 not used
Bit 1 = 1 -> Setpoint Digital (see P015, (Only with DI1 or DI2 not 3)
= 0 -> Setpoint Analog (see P015, (Only with DI1 or DI2 not 3)
Bit 2 = 1 -> Enable Output signal (Only with DI1 or DI2 not 1)
= 0 -> Disable Output signal (Only with DI1 or DI2 not 1)
Bit 3 = 1 -> Reset HB Alarm

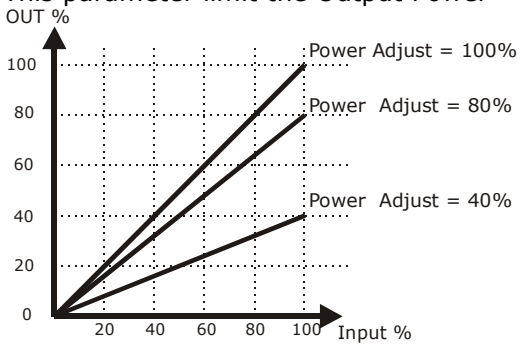
Note: When unit nis switch off all command parameter are set to 0

P015 (H0F) SP **Digital Set Poin** **%** **R/W**

Function: This parameter reads the Input command signal
When the P004 Bit1 =1 This parameter could be written and become the Input Command from RS485
Min/Max: 0 ÷ 1023 (0 ÷ 3FF Hex)
Value: from 0 = 0%,
To 1023 =100,0%.
Default: -
Example: Input 4mA -> P005L = 0 (0%)
Input 12mA -> P005L = 512 (50%)
Input 20mA -> P005L = 1023 (100%)
Note: -

P016 (H10) OutN **Maximum output** **%** **R/W**

Function: Its' a scaling factor of the Input command signal
Min/Max: 0 ÷ 255 (0 ÷FF Hex)
Value: from 0 = 0% of Output,
To 255 = 100% of Output.
Default: -
Example: -
Note: This parameter limit the Output Power



P018 (H12) F ir **Firing Type** **R/W**

Function: This parameter selects the Firing Type.
Min/Max: -
Value: 0= BURST firing mode
1= PHASE ANGLE mode
2= DELAY TRIGGERING mode
Default: 1 (if not specified in the Order Code)
Example: -
Note: -

P019 (H13) FEEd **Feed back selection** **R/W**

Function: This parameter selects the Feed-back type.
Min/Max:
Value: 0 = Current feed-back (rms value)
1 = Voltage feed-back (rms value)
2 = Power feed-back VxI
3 = None feed-back
Default: 1 (if not specified in the Order Code)
Example:
Note: Feed-back value is the average value on the three phase R, S, T

P020 (H14) bF_n **Burst Firing Cycles (Not used in PHASE ANGLE)** **Cycles** **R/W**

Function: It defines the number of voltage cycles in ON condition at 50% of power demand
Min/Max: 1 ÷ 255 cycles
Value: -
Default: 8 (if not specified in the Order Code)
Example: -
Note: -

P022 (H16) dt **Delay triggering** **°** **R/W**

Function: This parameter set firing delay in °
Min/Max: 0 ÷ 255 (0 ÷FF Hex)
Value: from 0 = 0°,
To 255 = 100°.
Default: 0
Example: -
Note: -

P023 (H17) rP_U **Sofstart - Ramp Up** **R/W**

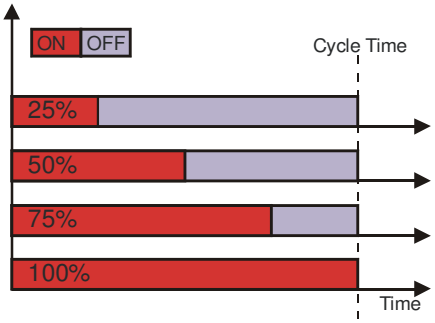
Function: This parameter have two functions: if the firing mode is Phase Angle de P023 is Time to reach the full angle of firing.
The Unit starts in phase angle mode with a ramp starting from zero up to full voltage in a presetted and Adjustable time.
The time is setted by this parameter
Min/Max: -
Value: -
Default: -
Example: -
Note: -

bF_r **Sofstart - Ramp Cycles of Burst** **Cycles** **R/W**

Function: If the firing is Burst Firing this parameter set the number of cycle.
In Burst Firing is possible to have a soft start ramp.
With this parameter you can define how much cycles are necessary to reach the complete wave form. You must set a value between 0 and the number of cycles setted in the parameter P083 bF_n . If you set 0 value the ramp is disabled
Min/Max:
Value: 0 ÷ 100 cycles
Default: 4 (with firing S+BF) 0 (wit other firing)
Example: -
Note: -

P024 (H18) ct in **Cycle time** **%** **R/W**

Function: The Cycle Time is the time which the Thyristor modulates to obtain the power demand
Min/Max: 0 ÷ 255 (0 ÷ FF Hex)
Value: Each step is 50msec
Default: 60 (3C Hex) = Zero Crossing
240 (F0 Hex) = Burst Firing
Example: With a Cycle time at 4 sec:
25%-> 1sec 0n+3sec off
50%-> 2sec 0n+2sec off
75%-> 3sec 0n+1sec off



Note: -

P026 (H1A) Pb **Proportional Band** **%** **R/W**

Function: This parameter is the gain of the feed-back loop
Min/Max: 0 ÷ 255 (0 ÷FF Hex)
Value: 0 ÷ 255
Default: VxI or V2 = 5 Hex
V or I =12 Hex
Example: -
Note: This parameter increase the loop speed but decrease the loop stability.

P027 (H1B) t i **Integral Time** **%** **R/W**

Function: This parameter is the integral time of the feed-back loop
Min/Max: 0 ÷ 255 (0 ÷FF Hex)
Value: -
Default: 50 Hex
Example: -
Note: If you increase integral time you increase the output stability, but you increase also the time to reach the set.

P028 (H1C) Hb_d **HB delay** **Sec** **R/W**

Function: This parameter set a delay to have HB alarm active
Min/Max: 0 ÷ 255 (0 ÷FF Hex)
Value:
Default:
Example:
Note:

P029 (H1D) Hb_S **HB sensitivity** **%** **R/W**

Function: This parameter defines the threshold of resistance that activates the HB alarm
This value is in percentage respect the nominal resistance load value
Min/Max: 0,0 ÷ 100,0%
Value: -
Default: 100,0
Example: .....Hb_S =20. This means that the Heather Break Alarm became active when the current goes below 80A
Note: -

P030 (H1E) bAud **Baud Rate** **R/W**

Function: This parameter selects the Baud rate on the serial port.
Min/Max:
Value: 0 = 4800
1 = 9600
2 = 19200
Default: 2
Example: -
Note: -

P031 (H1F) Addr **Address** **R/W**

Function: This parameter selects the Address on the serial port for the thyristor unit.
Min/Max: 1 ÷ 127
Value: -
Default: 1
Example: -
Note: -

P032 (H20) Cd.1 **Digital input 1 configuration** **R/W**

Function: This parameter selects the function of digital input.
Min/Max: -
Value: 0 = Additional Reset Alarm
1 = Setpoint Zero
2 = Feed-back Selection
3 = Setpoint Analog/Digital
4 = External Alarm
Default: 1
Example: -
Note: -

P033 (H21) Cd.2 **Digital input 2 configuration** **R/W**

Function: This parameter selects the function of digital input.
Min/Max: -
Value: 0 = Additional Reset Alarm
1 = Setpoint Zero
2 = Feed-back Selection
3 = Setpoint Analog/Digital
4 = External Alarm
Default: 1
Example: -
Note: -

P034 (H22) C_do1 **Digital output 1 configuration** **R/W**

Function: This parameter selects the function of digital input.
Min/Max: -
Value: 0 = Additional Reset Alarm
1 = Setpoint Zero
2 = Feed-back Selection
3 = Setpoint Analog/Digital
4 = External Alarm
Default: 1
Example: -
Note: -

P037 (H25) U_oP **Operative Load Voltage** **V** **R/W**

Function: This parameter is used to set in volt the operative voltage of the load.
Min/Max: 0 ÷ 1023 (0 ÷ 3FF Hex)
Value: from 0 = 0V,
To 1023 =1023V.
Default: 0
Example: -
Note: -

P038 (H26) A_Lo **Load nominal Current** **A** **R/W**

Function: This parameter is used to set the Load nominal Current.
Min/Max: from 0 = 0A,
To 1023 =102,3 A. for unit up to 90A

from 0 = 0A,
To 1023 =1023A. for unit over 90A
Value: -
Default: Max Current of REVO M (if not specified in the Order Code)
Example: Size of REVO M (Max Current) : 100A
Load nominal Current: 50A
P119 A_Lo =50.0
Note: This parameter is necessary to have the correct rescaling inside the unit. For this reason it's very important specify this value in the order code.

P044 (H2C) A_ In **Input type** **V** **R/W**

Function: Input type selection.
Min/Max: 0 ÷ 255
Value:
Default:
Example:
Note:

P045 (H2D) LoAd **Load Type** **R/W**

Function: This parameter set firing delay in °
Min/Max:
Value: 0=star
1=star+N
2=delta
3=open delta
Default: 0 (if not specified in the Order Code)
Example: -
Note: -

22 Maintenance

In order to have a corrected cooling, the user must clean the heat-sink and the protective grill of the fans. The frequency of this servicing depends on environmental pollution.
Also check periodically if the screw for the power cables and safety earth are tightened correctly (See Connection Diagram)

22.1 Trouble Shooting

Small problems sometimes can be solved locally with the help of the below tab of trouble shooting.
If you don't succeed, contact us or your nearest distributor.

Symptom	Indication on front unit	Possible reasons of the symptom	Actions
Load current doesn't flow	Green LED (ON) light OFF	• No Auxiliary Voltage • No input signal • Reversed polarities of input signal	• Give auxiliary voltage supply (See Connection Diagram) • Provide to give input signal • Reverse the input signal polarity
	Green LED (ON) light ON	• Fuse failure • Load connection interruption • Load failure: The yellow led (HB) is light on (with HB option) • Thyristor fault: The red led (SC) is light on (with HB option)	• Change the fuse • Check the wiring • Check the load • Change the thyristor module
Thyristor unit doesn't work properly		• Auxiliary voltage supply out of limits • Wrong input signal selection. • Wrong input signal calibration (out of range)	• Verify the auxiliary voltage supply • Control input signal setting. • Check input setting

22.2 Warranty condition

CD Automation gives a 12 months warranty to its products.
The warranty is limited to repairing and parts substitution in our factory and does exclude products not properly used and fuses.
Warranty does not include products with serial numbers deleted. The faulty product should be shipped to CD Automation at customer's cost and our Service will evaluate if product is under warranty terms.
Substituted parts remain of CD Automation property.

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